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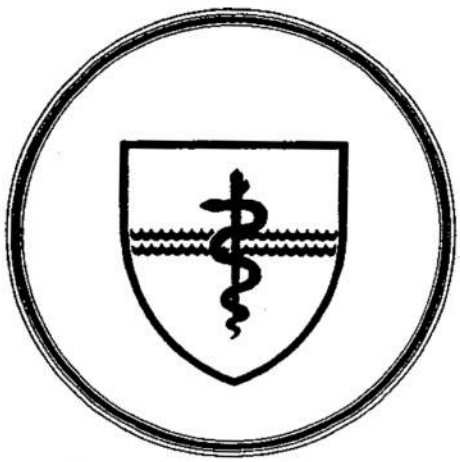

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Naval Medical Research and Development Command
Research Work Unit M0100.001-1023

Released by:

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Commanding Officer
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SUMMARY PAGE

PROBLEM

Owing to a marked increase in the need for eyeglasses among young men, the pool of visually qualified candidates for submarine service has decreased. This has necessitated a relaxation of visual standards and an increase in the number of waivers. There is now concern as to the level of visual performance of periscope operators in the fleet.

FINDINGS

Two solutions have been proposed, contact lenses and a modification of the periscope eyeguard to permit an operator's full refractive correction to be added to the periscope. The latter has now been evaluated at sea. There were no unforseen problems or mishaps, and the periscope modification appears to be a suitable back-up system for the contact lenses.

APPLICATION

The implementation of both proposed solutions will allow a relaxation of current visual standards for periscope operators, resulting in an increased pool of available candidates for submarine service while at the same time producing 20/20 corrected visual acuity for all periscope operators.

ADMINISTRATIVE INFORMATION

This research was conducted as part of the Naval Medical Research and Development Command Work Unit MR100.001-1023 - "Enhanced visual performance on submarines." It was submitted for review on 3 Sep 1985, approved for publication on 30 Sep 1985, and designated as NSMRL Report No. 1064.

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ABSTRACT

A proposed modification of the periscope eyeguard which permits the insertion of the operator's refractive correction was evaluated by three submarines on patrol. No unforeseen problems or mishaps were reported. Operators with large refractive errors were more favorably disposed to the modification than were operators with small refractive errors which could be corrected with the periscope optics. The periscope modification appears to be a satisfactory back-up system to improve the vision of those periscope operators who have large refractive errors.

INTRODUCTION

The increase in the need for eyeglasses among young men in the last generation (1) has made it increasingly difficult to find men who meet the visual standards of the submarine fleet (2). The problem is particularly important where periscope operators are involved. Uncorrected refractive errors are manifest as significant reductions in visual acuity (3, 4). The amount of correction which can be obtained with the optics of the periscope is limited for spherical errors and nonexistent for cylindrical errors. Periscope operators who have uncorrected refractive errors therefore suffer some degradation of vision (5, 6). The use of eyeglasses is inconvenient and not totally satisfactory, since the spectacle frames make it impossible to bring the eye to the proper position for periscope viewing.

Two solutions have been proposed (2). One is to fit periscope operators with refractive errors with contact lenses. This has been done with greater success than was anticipated (7). Nevertheless, a few problems remain. There are some individuals who cannot wear contact lenses. There is also the possibility that a contact lens will be lost or damaged, or that an eye infection or irritation will arise (8).

A second, back-up solution has therefore been proposed. It is a rather minor modification of the periscope eyepiece which allows the insertion of the operator's refractive correction (9). The operator would either carry an insert containing his correction or would store his insert near the periscope. This would have several advantages. The correction could be inserted or removed very quickly. It would completely correct all refractive errors, spherical and cylindrical. It would allow the operator to position his eye correctly. And it would eliminate the need to change the focus of the periscope optics. On the other hand, there are several conceivable disadvantages. It may not be convenient to carry the insert around or to store it near the periscope. An operator may forget to remove it when he leaves the periscope. Finally, the inserts may prove to be unacceptable for other reasons which cannot be foreseen.

To assess the acceptability of the eyepiece modification, periscope operators evaluated it during a patrol.

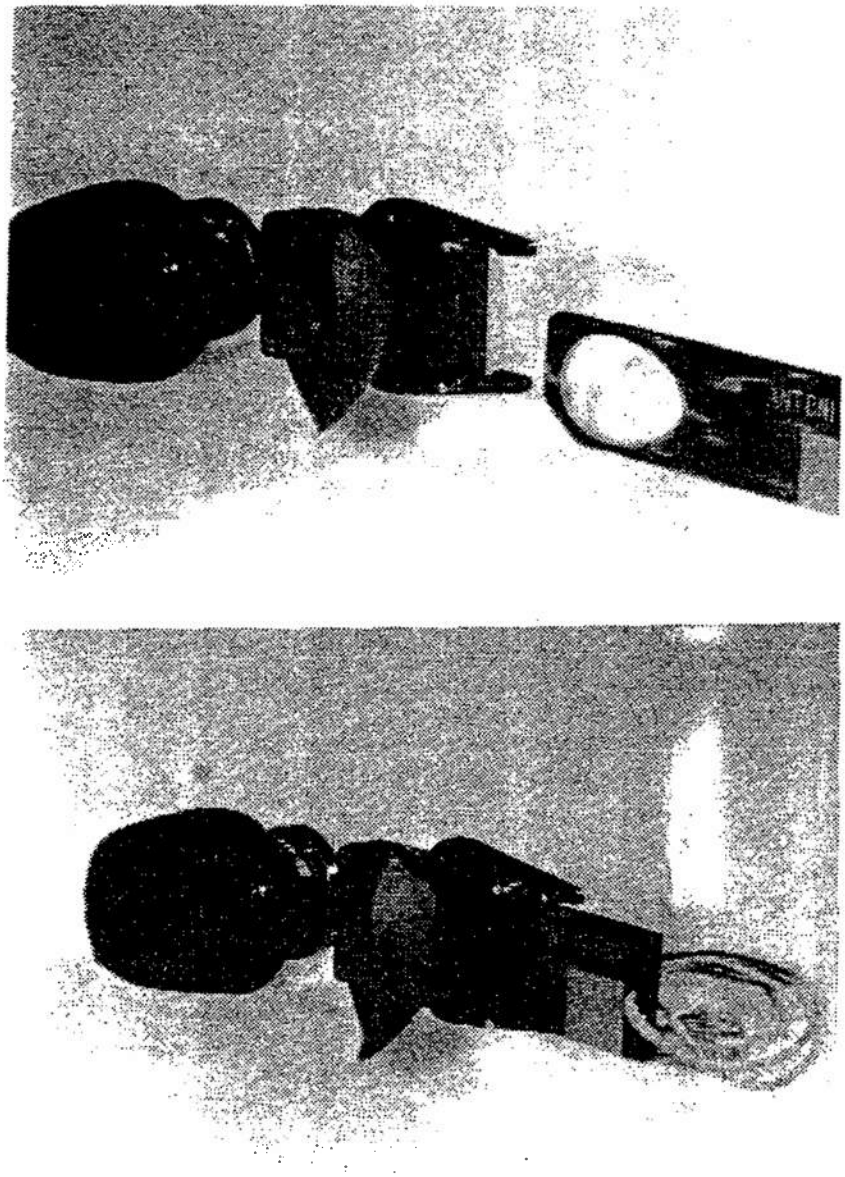

Fig. 1. A periscope eyeguard modified to permit the insertion of the refractive correction of the operator.

METHOD

The crews of three submarines (USS BIRMINGHAM, SSN 695; USS BOSTON, SSN 703; USS PHILADELPHIA, SSN 690) completed the evaluation. Each submarine was given a modified periscope eyepiece. The 11 periscope operators in each crew were given an optometric examination. It is highly noteworthy that every one of the 33 men was found to require a refractive correction. The corrections for their preferred eyes were mounted in plastic holders which could be inserted into the periscope eyepiece.

The Eyepiece Modification

Periscopes are monocular instruments, despite the fact that they appear to permit binocular viewing. Since some observers may prefer to use the left rather than the right eye, and since an observer may wish to change the eye he is looking with after an extended period of time, the periscope eyeguard is designed to be easily repositioned for viewing with either eye. It is thus not a fixed, inseparable part of the periscope. On the older periscopes, it was easily removed; on the newest periscope it does not easily detach, although of course it is easily repositioned. It is this feature which allows the present suggested modification to be rather easily made.

The periscope eyecup is attached to a plate which is almost thick enough to contain a spectacle lens. The proposed modification consists in simply machining a slot in this plate so that a holder containing a spectacle lens can be inserted just behind the eyecup (Fig. 1). This change could quite conceivably be carried out on the tender.

The Evaluation Questionnaire

The operators were requested to compare the visibility of their usual targets --ships, buoys, stars, landmarks, etc.-- when seen with and without the inserts. They were also to note whether or not the insert was inconvenient to use or prone to mishaps. At the end of the patrol, they were requested to fill out a questionnaire (Table I).

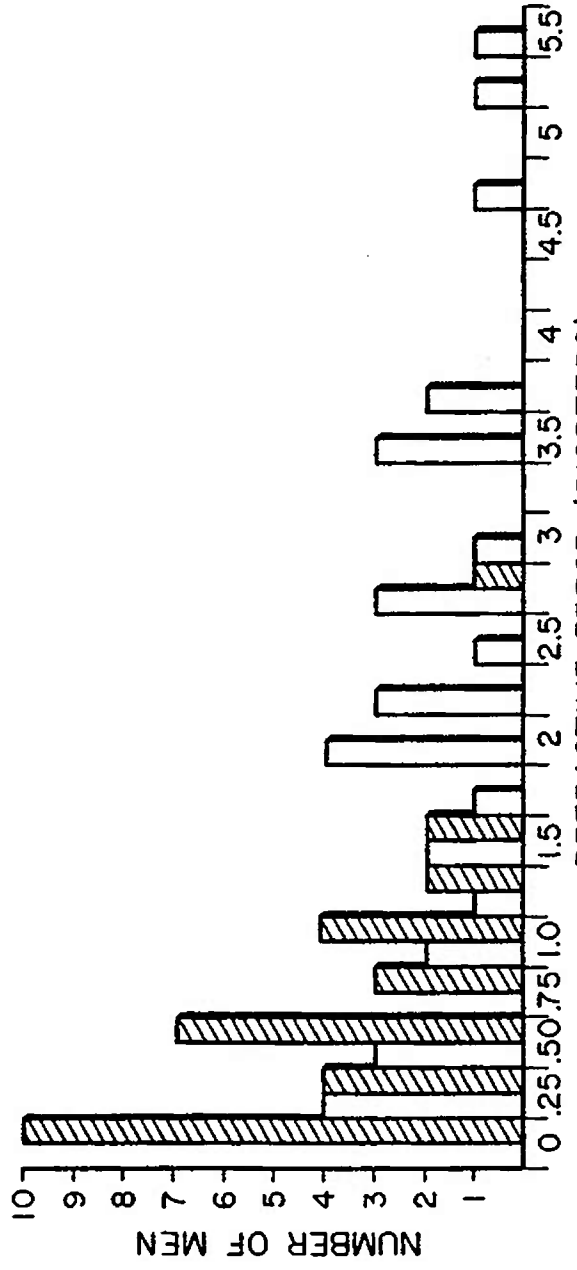

Fig. 2. Distribution of refractive errors on the periscope operators of the three crews. The open bars indicate spherical errors; the matched bars indicate cylindrical errors.

Table I. Final Evaluation of Periscope Insert

1. How often do you look through the periscope? How long do you keep looking through it during a given watch?
2. How well did the insert work? How much improvement or degradation was there? How did the fields of view compare?
3. Did you use the insert regularly in preference to your usual method of viewing?
4. How much trouble was the insert? How easy was it to use? Were there any mishaps? Was it worth the trouble?
5. Would you like to see this modification made to the periscopes?
6. Comments and suggestions.

RESULTS

Range of Refractive Errors Among Periscope Operators

The distribution of refractive errors among the periscope operators is shown in Fig. 2. The spherical refractive errors ranged from 0.25 to 5.50 diopters (D) on the USS Birmingham; from 0.25 to 3.50 D on the USS Philadelphia; and from 0.50 to 5.25 D on the USS Boston. The mean spherical correction (without regard for sign) was 2.20, 2.15, and 2.68 D for the three submarines, respectively. The cylindrical refractive errors ranged from 0.00 to 1.50 D on the first two submarines and from 0.00 to 2.75 D on the USS Boston, with means ranging from 0.47 to 0.75 D. It should be noted that these ranges are representative of those found on most other submarines (7).

Spherical errors up to about 5.00 D can be corrected by the optics of the periscope, but as Figure 3-- which is taken from Peters (4)-- shows, even half a diopter of myopia left uncorrected results in a reduction of visual acuity from 20/20 to 20/30. None of the cylindrical errors can be corrected by the periscope optics, and 1.5 D of astigmatism reduces visual acuity from 20/20 to about 20/60; 2.75 D of astigmatism reduces visual acuity to about 20/80 (4).

Results of the Evaluation

Half of the operators stated that they did not wish to see this modification made to the periscope. In general, these men had relatively smaller refractive errors. The mean spherical error of those men who stated either that they were indifferent to this modification or did not want it was 2.0 D; the mean spherical error of those who did want

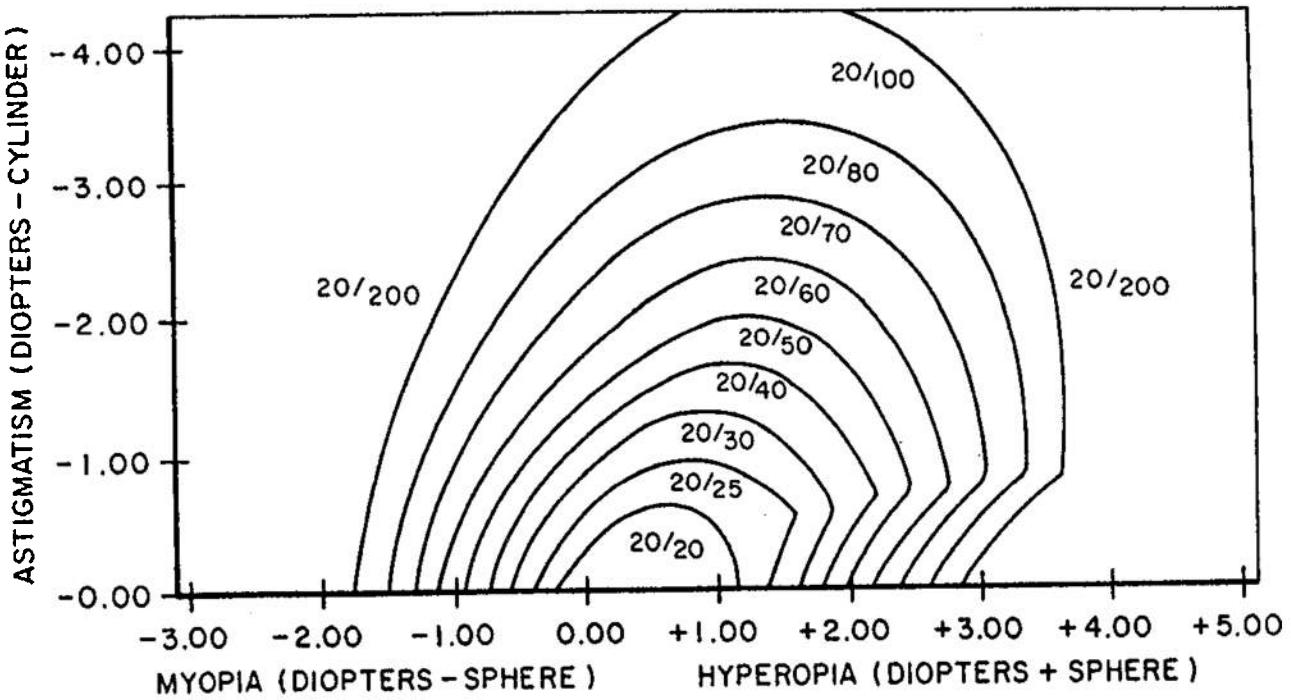

Fig. 3. The level of visual acuity produced by given magnitudes of spherical and cylindrical errors (Taken from Peters (4)).

it ranged from 3.5 to 5.25 D with a mean of 4.4 D. As one of the officers wrote in a summary letter, "Officers with vision requiring considerable correction found the eyepiece very useful in general and preferred the eyepiece over just the periscope." Surprisingly, however, one operator who had a spherical refractive error of only -0.50 D and a cylindrical error of 0.25 D noted that he "could see the detail of a towing cable on a ship clearly when I used the insert but could not without the insert."

Of those who did not vote for it, most were of the opinion that it was not worth the difficulty involved in adopting the modification. Many noted that contact lenses would be more useful, and even some of those who wanted the modification thought that contact lenses would be more useful. One officer recommended that "the insert be used only for people with eyes that (1) can't be fitted for contacts and also (2) aren't within the normal focal range of the scope."

No mishaps were reported with the inserts, and only one operator stated that the insert was troublesome to use. However, another man wrote that he had dropped two pairs of eyeglasses down the periscope wells, and he felt that the possibility of the same accident existed with the inserts.

As for the ease of use, one operator wrote that inserting the lens seemed to take as much time as focusing the periscope optics, although he could imagine that in poor light, focusing the periscope would be difficult, and the insert eliminates that need.

The most important drawback was pointed out by two men: it is that when the operator looks away from the periscope, he needs his correction to see in the control room. The insert makes it unnecessary to wear a correction while looking through the periscope, but it does not eliminate the necessity of wearing glasses when the operator looks away from the periscope.

DISCUSSION AND RECOMMENDATIONS

We have already compared the relative advantages and disadvantages of contact lenses and the periscope modification as a solution to the problem of periscope viewing by operators with refractive errors (2). The purpose of these sea-trials was to determine if there were any serious, unforeseen difficulties or inconveniences in the use of the inserts. There do not appear to be any that have not already been considered. These findings thus support our previous recommendations.

There is general agreement that the optimal solution to the problem of widespread refractive errors among periscope operators is extended wear contact lenses. When these can be worn, they eliminate all viewing problems not only with the periscope but with deck watches and emergency breathing masks as well (10). The inserts are recommended as a back-up for individuals who develop problems with their contact lenses, or for those who cannot wear them.

The adoption of both of these solutions would apparently eliminate all visual acuity problems through the periscope for virtually all operators. Refractive errors would no longer be a reason for rejecting men from the submarine service, and it would now be possible to adopt the same broader vision standards for refractive errors which exist for surface unrestricted line officers.

ACKNOWLEDGMENT

We thank the officers and men who participated in the evaluation.

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